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Map Projections with Freely Variable Aspect

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Introduction

Recent contributions to *Eos* [*Spilhaus*, 1981; *McBryde*, 1981; *Mantyla*, 1982; cf. also *Ross*, 1981; *McBryde*, 1982] have described map projections that will be valuable to oceanographers who need accurate but visually effective displays of the oceanic realm. The present article is an attempt to redress the balance in favor of students of the continents and more generally in favor of workers who need not—and in some cases should not—stipulate that parallels be horizontal straight lines. There are several very good introductions to the study of map projections [*Steers*, 1962; *Richardus and Adler*, 1972; *Snyder*, 1982], but it remains a somewhat inaccessible subject because of confused nomenclature and classification. I shall try here to make a grasp of the outlines of the subject more attainable by using a simpler notation and in particular by generalizing the troublesome concept of "aspect." This leads to a range of cartographic possibilities for effective portrayal of phenomena that are not regularly distributed with respect to the geographical coordinate system.

Recent examples of the use of map projections in the geosciences range from entertaining, as in the use [*Eckhardt*, 1983] of Lee's icosahedral projection [*Lee*, 1976] to display the Seasat geoid, to imaginative [*Hager and O'Connell*, 1981] and ingenious [*Harrison*, 1972]. Our impressions of planetary surface morphology are substantially improved by the maps of Venus, Earth, and Mars on orthographic and Sanson projections shown by *Kobrick* [1982]. On the other hand, problems in which the earth's rotation, and, therefore latitude, are physically important tend to evoke conservatism in cartographic illustration. Thus, oceanographers [e.g., *McBryde*, 1981; *Mantyla*, 1982] prefer maps on which lines of latitude or parallels are horizontal straight lines. Meteorologists seem to prefer maps on which lines of longitude or meridians are also straight; the use of the cylindrical equidistant projection is very widespread among climate modelers.

Simple projections such as the cylindrical equidistant are familiar to everybody, economical to produce, and compatible with the tabular format of most data storage schemes, but there is a price to be paid for this simplicity. It is difficult, for example, to visualize the polar regions adequately on a cylindrical equidistant projection and impossible on a Mercator projection. If geographical latitude is not an especially significant coordinate, as in studies of the distribution of plate boundaries [*Cogley*, 1984*c*] or of continental morphology [*Cogley*, 1984*a*, *b*], there is in principle no reason (other than a deep-rooted conviction that north is "on top") why parallels should be horizontal or even why they should be simple curves. Sometimes, maps have to serve conflicting requirements: In palaeogeography, base maps must be simple if they are to be convenient [*Smith and Briden*, 1977; *Smith et al.*, 1981], and palaeoclimatic interests are well served by maps with horizontal parallels [e.g., *Scotese et al.*, 1979], but the distribution of the continents is difficult to appreciate if several of them are smeared around the edge of the map.

In what follows we assume throughout that the earth is a sphere, not a spheroid, and to keep the development within manageable limits we deal only with single continuous projections. Interrupted and combined projections [e.g., *Spilhaus*, 1983; *Snyder*, 1977; *Miller*, 1941] are not considered. They involve complicated peripheral programing, and their appearance is sometimes difficult to predict in aspects other than the direct aspect. To show that the scope offered by continuous projections is very wide is one of the purposes of this paper.

Aspect Parameters

A map projection is a set, usually a pair, of equations that describes a transformation from three-dimensional spherical coordinates to two-dimensional rectangular coordinates. The inverse transformation is described by a set of inverse equations [e.g., *Cogley*, 1983]. In most uses of map projections the spherical radius is a constant, and the size of any given map is also a constant. These constants, and possibly a scale factor as well, can be applied as multipliers after other operations are completed, and they need not appear in the equations that define the map projection. Nevertheless, we require in general three spherical coordinates to specify completely the transformation from the sphere to the map plane. This is because during the transformation we may wish to change not only the origin but also the orientation of the coordinate system. In other words, we may wish to rotate the coordinate system as well as to translate it along one or both of the available directions.

The simplest mental picture of these operations is obtained by looking on the geographical coordinate system of parallels and meridians as a rigid wire mesh fixed in place on the sphere. The eventual map coordinate system can then be seen as a second rigid wire mesh which can be moved over the sphere at will. At first the two meshes coincide, but we can choose to shift the origin of the second mesh anywhere we want and we can tilt the second mesh at any desired angle to the first. The map projection is done from the second mesh to the plane of the map. By splitting the procedure in this way we achieve a considerable reduction in the quantity of notation. Projections are always defined with respect to the same coordinate system (the second wire mesh), and the aspect of any map is defined in terms of a rotation which has nothing to do with the projection being used.

This rotation is formally identical with the finite rotations used by tectonicists to reassemble continents; it is defined by

$$\mathbf{x} = \mathbf{S}\mathbf{x}' \qquad (1)$$

where $\mathbf{x} = (\cos\theta\cos\lambda, \cos\theta\sin\lambda, \sin\theta)$ is the map coordinate system (i.e., that of the second wire mesh), $\mathbf{x}' = (\cos\theta'\cos\lambda', \cos\theta'\sin\lambda', \sin\theta')$ is the geographical coordinate system, and $\mathbf{S}$ is the rotation matrix [*Kreyszig*, 1979, pp. 397–401]. Geographical latitude and longitude are θ' and λ', respectively. The rotation matrix can be specified in terms of three spherical "Euler angles," those chosen here being the geographical latitude θ_0 and longitude λ_0 of the origin and the azimuth ρ. The azimuth is the angle made at the origin between rays to the north poles of the geographical and map coordinate systems; it is positive counterclockwise from geographical north, so that a positive azimuth puts the geographical north pole in the right half of the map. Figure 1 gives a derivation of the rotation matrix, following, for example, *Jeffreys and Jeffreys* [1956] but in a form suitable for programing.

The Euler angles $(\theta_0, \lambda_0, \rho)$ are not the same as those used to reassemble continents, since the three component rotations are about different sets of axes in the two procedures. In plate tectonics only one continental outline is rotated at a time, whereas here the entire contents of the map are being rotated. The advantage of choosing θ_0, λ_0, and ρ is that they are easy to visualize in terms of the desired end product: θ_0 and λ_0 usually define the physical center of the map, while ρ can be estimated with fair accuracy by eye on a globe or other map.

Table 1 is a list of selected projections, including some in common use and some made more useful or versatile when the principles discussed in this article are applied to them. The table emphasizes that all the commonly recognized aspects of these projections are contained within their defining formulae and equation (1). Thus, for example, there is no need to discuss separately the direct, oblique, and transverse (i.e., polar) aspects of the stereographic projection. However, the terminology of aspect makes a good introduction to the "new" projections to be discussed in the next section. *Wray* [1974] shows that in general there are seven distinct aspects, not the conventional three. (There are projections with more than seven aspects, but they are not considered here.) Most of the common projections are conical (i.e., azimuthal, conic, or cylindrical), and in conical projections four of the seven aspects reduce in pairs to the oblique and the direct aspects. Since the graticule has an axis of symmetry one of its coordinates, the longitude, is arbitrary in that a rotation through an angle of longitude leaves the graticule unchanged. Thus for a given λ_0 only three aspects are available in a conical projection: direct, with $\theta_0 = 0°$; transverse, with $\theta_0 = \pm 90°$; and oblique, in fact infinite in number but by convention regarded as one, with $0° < |\theta_0| < 90°$. In conical projections the third aspect parameter, the azimuth, is redundant, and its only effect is to rotate the image of the graticule. Although this effect can be achieved more cheaply by looking at the map slantwise, it can be useful to specify the three aspect parameters explicitly in combination with the four "window parameters." These last control the extent of the map and can be specified as the four distances in degrees of arc from the origin to the left, right, top, and bottom edges of the map.

The three aspect parameters offer more scope for experimentation when the projection is not conical. The fundamental triangle of the projection [*Wray*, 1974] is now no longer degenerate, and there is one aspect for each of its vertices, one for each of its sides, and one for its center. Again, the off-vertex aspects are infinite in number, and again one of the coordinates of the graticule is arbitrary. The aspect parameter λ_0 provides only a translation of the earth's surface beneath a graticule the physical appearance of which does not change; this translation is of course often crucial to the appearance of the finished map. However, it is the existence of two nontrivial aspect parameters that makes nonconical projections so interesting.

There are many such projections, but here we shall consider only those that have elliptical limbs. A fundamental fact in the study of map projections is that the sphere is not a developable surface. In topological terms this means that the sphere cannot be mapped into the plane without one or more cuts followed by one or more continuous distortions. For example, the Mercator requires two "pinpricks," one at each pole of the map graticule, while the stereographic and Lambert azimuthal equiareal require one pinprick at the antipodes of the origin. In general, projections with elliptical limbs require a cut of length 180° between the poles of the map graticule along the meridian antipodal to the origin; this cut is, in fact, the limb of the projection. Because we now have three aspect parameters rather than two, we are able to make the cut along any half great circle we choose.

Both cuts and distortions are inevitable in any map projection, and a practical consequence of this is that all maps portray some regions well and other regions badly. When choosing a projection to suit a particular purpose, one of the aims is therefore to assemble the interesting parts of the world in well-portrayed parts of the projection and to have badly portrayed parts of the projection correspond to less interesting parts of the world (if any). A movable limb, as provided by the three aspect parameters, considerably increases the scope for approaching this aim.

In the next section, these ideas are illustrated with a series of maps in which the third Euler angle, the azimuth, is nonzero. The ideas themselves are not new: Finite rotations on the sphere [*Jeffreys and Jeffreys*, 1956] have been understood for 200 years, and understanding of their application to map projections has grown more explicit during the present century. One of the earliest uses of a nonzero azimuth was by *Fairgrieve* [1928; cf. also *Close*, 1929], while *Spilhaus* [1942, 1975] seems to have been the first to appreciate the generality and potential of the idea and *Wray* [1974] provided an important mathematical framework for it. I consider the presentation given above to be an advance because it simplifies the notation; it is probable that the essence of the simplification is already embodied in computer programs at many centers of cartographic research [e.g., *Morrison*, 1980; *Metzger*, 1984].

Illustrations

The climate modeling and remote sensing community [e.g., *Manabe and Stouffer*, 1980; *Hartmann and Short*, 1980] seems to be content to show its results in very simple cartographic format. Climatologists do not often venture beyond cylindrical projections, usually the cylindrical equidistant, supplemented by assorted transverse-aspect maps of the north and south polar regions; *Stephens et al.*'s use [1981] of the Hammer projection is unusual. This is a pity because the interaction of the poles with the middle and low latitudes is a central problem in modern climatology. Such questions as why the equatorial regions are not hotter than ~30°C, why the south pole is colder than the north pole, and why the equator-to-pole temperature difference is of the order of 50°C (rather than 20°C as

Article (*cont. on p. 482*)

TABLE 1. Defining Equations for Representative Map Projections

		Azimuthal
$R = \alpha$	$0 \le \alpha < \pi$	azimuthal equidistant
$R = \sin\alpha$	$0 \le \alpha < \pi/2$	orthographic
$R = \sin\alpha$	$\pi/2 < \alpha \le \pi$	demon's eye
$R = 2\sin(\alpha/2)$	$0 \le \alpha < \pi$	Lambert azimuthal equiareal
$R = \tan\alpha$	$0 \le \alpha < \pi/2$	gnomonic
$R = 2\tan(\alpha/2)$	$0 \le \alpha < \pi$	stereographic (v. infra)
		*Cylindrical**
$V = \theta$		cylindrical equidistant
$V = \sin\theta$		cylindrical equiareal
$V = (1 + \sqrt{2}/2)\tan(\theta/2)$		Gall's "stereographic"
$V = \psi$		Mercator (v. infra)
		Nonconical
$U = \lambda\cos\theta$	$V = \theta$	Sanson
$U = (2\sqrt{2}/\pi)\lambda\cos c$	$V = \sqrt{2}\sin c$	Mollweide (c is defined by $2c + \sin 2c = \pi\sin\theta$ and can be found by iteration or polynomial approximation)
$R = \beta$	$A = 2$	Aitoff
$R = 2\sin(\beta/2)$	$A = 2$	Hammer
$R = 2\sin(\beta/2)$	$A = 7/4$	Briesemeister
		Conformal†
$M = \psi + i\lambda$		Mercator
$S = \tanh\frac{1}{2}M$		stereographic
$L = \tanh\frac{1}{4}M$		Lagrange
$Mi = S + pS^3$		Miller oblated stereographic
$Au = L - \frac{1}{3}L^3$		August
$Lr = 2\,\mathrm{sc}^{-1}(L/\sqrt{k'})$		Lee rectangular
$Le = \sinh[\pi Lr/(4K')]$		Lee elliptic
$Lt = \mathrm{sd}^{-1}(2\exp M)$		Lee tetrahedric

Notation: θ = latitude; ψ = isometric latitude = arcsinh (tanθ); λ = longitude; α = arc distance from origin = arccos ($\cos\theta\cos\lambda$); β = arccos [$\cos\theta\cos(\lambda/2)$]; h = arccos ($\sin\theta/\sin\alpha$), $0 < \alpha < \pi$; U = map easting = $AR\sin h$; V = map northing = $R\cos h$; $R\,(U^2 + V^2)^{1/2}$; A = 1 unless specified otherwise; $i = \sqrt{-1}$. Earth radius and other scale factors (except p) are assumed equal to 1. k', K' are parameters of elliptic integrals; sc, sd are Jacobian elliptic functions [*Lee*, 1976; *Abramowitz and Stegun*, 1966].

*Domain is $-\pi/2 < \theta < \pi/2$ and easting $U = \lambda$.

†Domains vary, some projections having several singular points; U = ImZ, V = ReZ, where Z is the quantity on the left side of the defining equation.

If $|\theta_0| < \pi/2$, put

$$\sin\theta_p = \cos\theta_0\cos\rho$$
$$\sin\theta_c = \cos\theta_0\sin\rho$$

$$\operatorname{sgn}\rho = \begin{cases} \rho/|\rho| & |\rho| \le \pi/2 \\ -\rho/|\rho| & |\rho| > \pi/2 \end{cases} \quad \text{(see note)}$$

and

$$\lambda_p = \begin{cases} \lambda_0 - \operatorname{sgn}\rho\,\arccos(-\tan\theta_p\tan\theta_0) & |\theta_p| < \pi/2 \\ \pi\,\operatorname{sgn}\theta_0 & |\theta_p| = \pi/2 \end{cases}$$

$$\lambda_c = \begin{cases} \lambda_0 + \arccos(-\tan\theta_c\tan\theta_0) & |\theta_c| < \pi/2 \\ \lambda_c & |\theta_c| = \pi/2 \end{cases}$$

If $|\theta_0| = \pi/2$, put

$$\theta_p = 0 \qquad \lambda_p = \begin{cases} \lambda_0 + \pi & \theta_0 = \pi/2 \\ \lambda_0 & \theta_0 = -\pi/2 \end{cases}$$

$$\theta_c = 0 \qquad \lambda_c = \lambda_0 + \pi/2$$

Then, the rotation $\mathbf{x} = \mathbf{S}\mathbf{x}'$ is

$$\begin{pmatrix} \cos\theta\cos\lambda \\ \cos\theta\sin\lambda \\ \sin\theta \end{pmatrix} = \begin{pmatrix} \cos\theta_p\cos\lambda_p & \cos\theta_p\sin\lambda_p & \sin\theta_p \\ \cos\theta_c\cos\lambda_c & \cos\theta_c\sin\lambda_c & \sin\theta_c \\ \cos\theta_0\cos\lambda_0 & \cos\theta_0\sin\lambda_0 & \sin\theta_0 \end{pmatrix} \begin{pmatrix} \cos\theta'\cos\lambda' \\ \cos\theta'\sin\lambda' \\ \sin\theta' \end{pmatrix}$$

The signum function, sgn, need not be defined for $|\rho| > \pi/2$, but it is convenient to do so.

Fig. 1. The algebra of Eulerian rigid rotation in a form suitable for computer cartography. All angles are in radians.

Article (cont. from p. 481)

TABLE 2. Useful Sets of Aspect Parameters

Parameter	Subject	Source
25, −5, 30	landmasses (limb from Alaska to southern Pacific)	Cogley*
28, 178, 70	landmasses (limb from Florida to Indian Ocean)	Cogley*
60, 10, 70	continents	*Cogley* [1984*a*, *b*]
45, 80, −30	Eurasia	*Cogley* [1984*b*]
50, −90, 10	North America	*Cogley* [1984*b*]
30, 60, 43	Afroeurasia in front hemisphere	Cogley*
45, −30, −90	landmasses (limb from east Pacific to central Indian Ocean; poles on horizontal midline)	Bartholomew's atlases
45, 0, 0	inhabited landmasses	*Briesemeister* [1953]
0, 20, −70	landmasses (limb from Hanoi to Iquique)	*Spilhaus* [1975]
−70, 15, 90	world ocean	*Spilhaus* [1942]
0, 48, −45	British Commonwealth	*Fairgrieve* [1928]
37, 12, 15	global plate boundary system, cut by limb in only one place	*Cogley* [1984*c*]
−35, 168, 20	global plate boundary system, cut by limb in only two places ("back view")	*Cogley* [1984*c*]
0, λ_0, ±90	thetaform equator enclosing poles	various [e.g., *Steers*, 1962]

In degrees.
*Unpublished data.

during the Cretaceous), are not answerable by cartographic means; however, a more venturesome use of available map projections may help in deciding, for example, whether these questions are the right ones to ask. The top figure on the cover shows the global distribution of annually averaged surface albedo on a Mollweide equiareal projection with aspect parameters (θ_0, λ_0, ρ) = (0, 50, -90). Surface albedo is an important climatic variable because of its role in the radiation balance and the feedback which it provides through its nonlinear dependence on temperature. The top figure on the cover shows that the hemispheric distributions of surface albedo are quite different. Both have polar maxima, but the northern maximum is more extensive and of lesser amplitude than the southern. Superimposed on the dominant zonal alignment of the contours can be seen the important influence of land-sea contrasts, the lesser but significant roles played by sea ice extent and dynamics and by subsidence in tropical latitudes, and a variety of meridional structures due to topography and other factors. A map in which both poles are equally well displayed can be a thought-provoking adjunct to conventional maps in which either both poles are badly displayed or one pole is not shown at all. Naturally, one does not get something for nothing: We have had to sacrifice realism at the equator, which has become a theta-shaped object comprising the vertical midline of the map and the limb.

The bottom figure on the cover illustrates a problem in which the regions around the limb of the map can legitimately be regarded as "uninteresting." This is an attempt to show the continents in their relationships to each other, with particular reference to their extent and to their serial contiguity. The aim is thus to keep continents away from the limb, and to do this it is necessary to find a half great circle which passes entirely through the oceans. A number of lines meet this requirement. *Spilhaus* [1975] suggested a limb extending from Hanoi to Iquique and defined by the aspect parameters (0, 20, -70), but this limb cuts through continental crust in the South China Sea. In the bottom figure on the cover the limb runs from the neighborhood of Guatemala to a point west of Perth, Australia, and produces a pleasing and informative arrangement of the continents.

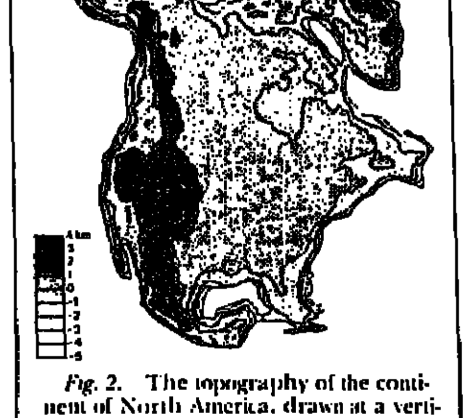

Fig. 2. The topography of the continent of North America, drawn at a vertical interval of 1 km on a Hammer equiareal projection (50, -90, 10).

The map is drawn on a projection due to *Lee* [1976] which achieves the remarkable feat of mapping the whole sphere conformally into an ellipse. The common conformal projections have one or more points at infinity, and this new whole-earth conformal mapping, which is free of gross distortion, deserves to be more widely known. It is important to caution the viewer that the conformality of the map guarantees local correctness of shape but at the same time guarantees inequality of areas from locality to locality. The continent of New Zealand is somewhat smaller than Arabia, not several times larger, and the continents as a whole occupy 41% of the earth's suface, not ~20% as suggested by the bottom figure on the cover. Most of the continents, however, are displayed with comparatively minor interior distortion, and regional subjects such as the separation of Madagascar from Africa or of South America from Antarctica are accurately depicted. For some purposes the separation of Antarctica from Australia might be considered a flaw, but this can easily be remedied with a different choice of aspect parameters. Table 2 lists several other parameter sets that serve a variety of purposes related to large-scale tectonics and other matters.

The apparatus used in selecting the parameter sets of Table 2 consists of a globe and a length of knotted string. Usually a first guess followed by a fine adjustment is enough to yield satisfactory results.

Note that the selection of a particular aspect is independent of the choice of map projection. The same map as shown as the bottom figure on the cover is shown in *Cogley* [1984*a*] on a Hammer equiareal projection.

The utility of projections with three nonzero aspect parameters is not restricted to maps of the whole world. Figure 2 is a map of the continent of North America drawn on a Hammer (50, -90, 10); the origin is at the center of the object of attention, and a small clockwise rotation gives the map a qualitative symmetry which would be lacking if its center line were a geographical meridian. The northernmost and westernmost parts of North America often receive inadequate treatment in standard maps centered on the equator or the north pole, and few printed maps are equiareal. Equality of areas is a prerequisite for purposes such as the hypsometric comparisons for which Figure 2 was drawn [*Cogley*, 1984*b*].

As a final illustration of the potential of skew projections, consider a problem mentioned earlier, viz., the difficulty of simultaneously achieving conflicting aims in palaeogeographic mapping. The need to appreciate at a glance the latitudinal disposition of the continents is rightly regarded as paramount by such workers as *Scotese et al.* [1979] and *Smith et al.* [1981]. However, the price paid for this decision is that in at least some palaeogeographic maps some of the important details are unrecognizable because they are near the edge of the map. The cost is only partly recouped by presenting back views as well as front views, a point well illustrated by the middle Silurian maps of *Scotese et al.* [1979]. Figure 3 shows some of the detail from Scotese et al.'s Figures 15 and 16 on a Briesemeister (-35, 20, -30), which has a limb passing through the oceans of the Silurian world. The convenience of straight parallels and zonal symmetry is lost in Figure 3 but is partially regained by emphasizing the parallels and the poles at the expense of the meridians (which are somewhat arbitrary in this context). Maps such as Figure 3 are valuable supplements to standard palaeogeographic maps because palaeoclimatology is only a part of palaeogeography. Magnetically determined palaeolatitudes are of course the key to continental reconstruction, but, apart from this technical point, geographical latitude is only significant in palaeotectonics if one wishes to consider ellipsoidal membrane stresses. Maps such as Figure 3, and for that matter the bottom figure on the cover and Figure 2 also, have exactly the same mathematical validity and physical meaning as maps that have symmetry with respect to the earth's axis of rotation, and they share their stated purposes either equivalently or better.

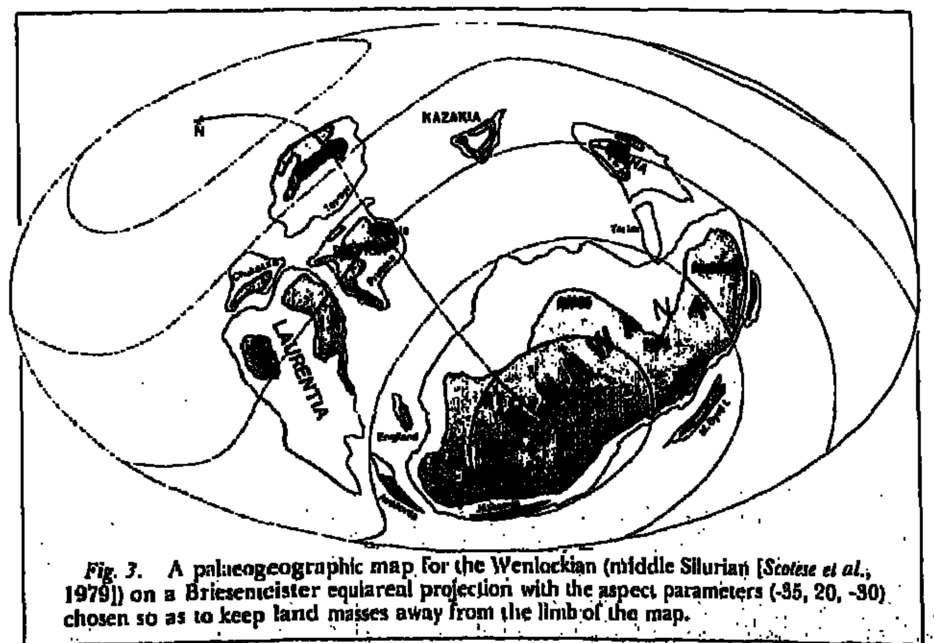

Fig. 3. A palaeogeographic map for the Wenlockian (middle Silurian [*Scotese et al.*, 1979]) on a Briesemeister equiareal projection with the aspect parameters (-35, 20, -30) chosen so as to keep land masses away from the limb of the map.

Conclusion

The convenience of maps on which parallels and meridians are regular curves is obvious: It is easy to add detail to them by hand, and the results of different workers are easier to compare if they are shown on widely used projections. More adventurous use by the geoscience community of a wider range of projections would, however, be a welcome development. It would help us in the generation of new questions and in the unlearning of old prejudices. For example, the large size of Greenland and the remoteness of Siberia and Alaska (which are tectonically contiguous) are widely and wrongly believed in because of our limited cartographic diet. The tectonics of the Arctic remains obscure today for a number of reasons, among them not only the inaccessibility and complexity of the subject matter but also the choice of direct-aspect Mercator maps to express the main ideas of plate tectonics in the 1960's. Similarly, one cannot help but suspect that the weakness of general circulation climate model performance at high latitude is due in some part to mapping conventions which deemphasize the geography of the polar regions. Divorcing the aspect of a map projection from its defining equations, as explained above, is a valuable advance in cartographic technique which should help earth scientists to increase the versatility and sophistication of their pictures of spatially distributed phenomena.

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References

Abramowitz, M., and I. A. Stegun, *Handbook of Mathematical Functions*, Dover, New York, 1966.
Briesemeister, W., A new equal-area projection, *Geogr. Rev.*, *43*, 260–261, 1953.
Close, C. F., An oblique Mollweide projection of the sphere, *Geogr. J.*, *73*, 251–253, 1929.
Cogley, J. G., DIGIT—An interactive processor for digitized data, *Computers Geosci.*, *9*, 123–155, 1983.
Cogley, J. G., Continental margins and the extent and number of the continents, *Rev. Geophys. Space Phys.*, 22, 101–122, 1984*a*.
Cogley, J. G., Hypsometry of the continents, *Zeit. Geomorph.*, in press, 1984*b*.
Cogley, J. G. Global plate statistics, *Tectonics*, in press, 1984*c*.
Eckhardt, D., Cover, *Eos Trans. AGU*, *64*, 424, 1983.
Fairgrieve, J., A new projection, *Geography*, *14*, 525–526, 1928.
Hager, B. H., and R. J. O'Connell, A simple global model of plate dynamics and mantle convection, *J. Geophys. Res.*, *86*, 4843–4867, 1981.
Harrison, C. G. A., Poles of rotation, *Earth Planet. Sci. Lett.*, *14*, 31–38, 1972.
Hartmann, D. L., and D. A. Short, On the use of earth radiation budget statistics for studies of clouds and climate, *J. Atmos. Sci.*, *37*, 1233–1250, 1980.
Hummel, J. R., and R. A. Reck, A global surface albedo model, *J. Appl. Meteorol.*, *18*, 239–253, 1979.
Jeffreys, H., and B. S. Jeffreys, *Methods of Mathematical Physics*, 3rd ed., Cambridge University Press, New York, 1956.
Kobrick, M., Topography of the terrestrial planets, *Astronomy*, *10*, 18–22, 1982.
Kreyszig, E., *Advanced Engineering Mathematics*, 4th ed., John Wiley, New York, 1979.
Lee, L. P., Conformal projections based on elliptic functions, *Cartographica*, *Monogr. 16*, B. V. Gutsell, c/o Univ. of Toronto Press, Toronto, Ont., 1976.
Manabe, S., and R. J. Stouffer, Sensitivity of a global climate model to an increase of CO_2 concentration in the atmosphere, *J. Geophys. Res.*, *85*, 5529–5554, 1980.
Mantyla, A. W., Projection ponderings, *Eos Trans. AGU*, *63*, 179, 1982.
McBryde, F. W., Pondering projections, *Eos Trans. AGU*, *62*, 1162, 1981.
McBryde, F. W., Mollweide graticule shortcomings, *Eos Trans. AGU*, *63*, 522, 1982.
Metzger, D., Cover, *Eos Trans. AGU*, 65, 136, 1984.
Miller, O. M., A conformal map projection for the Americas, *Geogr. Rev.*, *31*, 100–104, 1941.
Morrison, F., Computing the potential and attraction of a density layer by means of elliptic integrals, *Manuscr. Geodaet.*, *5*, 145–173, 1980.
Richardus, P., and R. K. Adler, *Map Projections*, North-Holland/American Elsevier, New York, 1972.
Ross, D. A., Marine science and the law of the sea, *Eos Trans. AGU*, *62*, 650–652, 1981.
Scotese, C. R., R. K. Bambach, C. Barton, R. Van der Voo, and A. M. Ziegler, Paleozoic base maps, *J. Geol.*, *87*, 217–277, 1979.
Smith, A. G., and J. C. Briden, *Mesozoic and Cenozoic Paleocontinental Maps*, Cambridge University Press, New York, 1977.
Smith A. G., A. M. Hurley, and J. C. Briden, *Phanerozoic Paleocontinental World Maps*, Cambridge University Press, New York, 1981.
Snyder, J. P., A comparison of pseudocylindrical map projections, *Am. Cartogr.*, *4*, 59–81, 1977.
Snyder, J. P., Map projections used by the U.S. Geological Survey, *U.S. Geol. Surv. Bull. 1532*, 1982.
Spilhaus, A., Maps of the whole world ocean, *Geogr. Rev.*, 32, 431–435, 1942.
Spilhaus, A., Geo-Art: Plate tectonics and platonic solids, *Eos Trans. AGU*, *56*, 52–57, 1975.
Spilhaus, A., Opinion, *Eos Trans. AGU*, *62*, 652, 1981.
Spilhaus, A., Cover, *Eos Trans. AGU*, *64*, 136, 1983.
Steers, J. A., *An Introduction to the Study of Map Projections*, 13th ed., University of London Press, London, 1962.
Stephens, G. L., G. G. Campbell, and T. H. Vonder Haar, Earth radiation budgets, *J. Geophys. Res.*, *86*, 9739–9760, 1981.
Wray, T., The seven aspects of a general map projection, *Cartographica*, *Monogr. 11*, B. V. Gutsell, c/o Univ. of Toronto Press, Toronto, Ont., 1974.

J. G. Cogley *is an associate professor of geography at Trent University, where he lectures in geology, geomorphology, climatology, and related subjects. He took his B.A. from the University of Oxford and his M.Sc. and Ph.D. from McMaster University. After a visiting year at the University of Toronto, he has been at Trent since 1974. His doctoral work was on the fluvial geomorphology and hydrology of High Arctic terrains on Devon and Cornwallis islands and developed into an analysis of water and energy balances. It lead to research on ice-dammed lakes on Ellesmere Island and on the hydrological problems of possible pipeline routes on Ellesmere Island and in Keewatin. More recently, his work has focused on problems in palaeogeography and the dynamics of ancient climates, cloud and radiation climatology of the Arctic, large-scale geomorphology and tectonics, and geoscience applications of computer graphics. He is especially interested in strengthening the interaction between physical geography and geophysics.*

Forum

Moving AGU Meetings Sites

A recent letter to *Eos* by AGU member Dan Baker (March 14, 1984, p. 98) suggested that a method of reducing the attendance at the Fall AGU meeting would be to move it from San Francisco to his namesake, namely Bakersfield. He cited as a precedent the probably reduced attendance at the (at that time) upcoming Spring Meeting to be held in Cincinnati. While neither of us is promoting cities with names similar to ours, nevertheless we both believe that the recent meeting held in Cincinnati was a great success, even with the reduced number of registrants. The arrangements in the Convention Center, as well as the proximity of the hotels to the convention center and the amenities in the hotels were all excellent, and easily matched or surpassed the facilities in any of the cities in which the major meetings have been held to this time. Furthermore, we would like to make a qualitative judgment that the number of attendees at the individual sessions were perhaps as large as in a Baltimore or Washington meeting. In those meetings the number of registrants may have been larger, but the number of attendees at the given session may have been smaller; a significant proportion of the attendees at any given time would likely be visiting the offices of their contract monitors. Admittedly, the Spring Meeting has been an ideal opportunity to both attend scientific sessions and to lobby for additional research support. However, such lobbying does not necessarily make for increased attendance at the scientific sessions.

In summary, we applaud the program committee for finding such an excellent site for a meeting as Cincinnati. We think that those who failed to attend missed an excellent technical meeting as well as one with outstanding logistical arrangements.

L. J. Lanzerotti
C. C. Maclennan
AT&T Bell Laboratories, Murray Hill, N.J.

EOS
Transactions, American Geophysical Union
The Weekly Newspaper of Geophysics

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Cover. (Top) Annually averaged surface albedo, based on the 10° x 10° estimates of *Hummel and Reck* [1979]. The projection is a Mollweide with aspect parameters (0, 50, -90). (Bottom) The extent of the continents, after *Cogley* [1984*a*], with submerged and subaerial portions indicated by yellow and brown, respectively. The projection is a Lee elliptic conformal (60, 10, 70). (Figures courtesy of J. Graham Cogley, Department of Geography, Trent University, Peterborough, Ontario, Canada. See article, "Map Projections With Freely Variable Aspect," by J. Graham Cogley, this issue.)

News

Satellite Troubles

Two satellites operated by the National Oceanic and Atmospheric Administration (NOAA) encountered serious trouble recently.

The Geostationary Operational Environmental Satellite (GOES) that provided weather pictures for the eastern half of the United States and Canada, all of Central and South America, and much of the Atlantic Ocean, failed on July 29; an incandescent lamp for the encoder burned out. In mid June, the NOAA-8 environmental monitoring satellite lost its attitude control system and began tumbling in orbit at the beginning of July. The satellite includes a payload called SARSAT that enables the satellite to relay emergency signals from downed aircraft and ships in distress.

In response to the blanking out of GOES-5, also known as GOES-East, NOAA moved its sister satellite, GOES-6, also known as GOES-West, eastward from over the equator at 135°W longitude to 98°W longitude, according to William M. Callicott, deputy director of NOAA's office of satellite data processing and distribution. The troubled GOES-5 had been at 75°W longitude. The shift enabled GOES-6 to monitor the United States and to help watch for hurricanes during this peak season. The western Pacific Ocean, Hawaii, Alaska, and the eastern portion of the Atlantic Ocean are not being monitored by a geostationary satellite, but polar satellites pass over the areas twice daily.

Although GOES-5 can no longer make images to send to earth, its communications transponder still works, Callicott said. Data collected by the functional GOES-6 can be transmitted over the GOES-5 transponder; weather facsimile data also can be processed for users at the fringe of the satellite coverage.

Built by Hughes Aircraft Co. and launched in 1981, the $40-million GOES-5 satellite was expected to operate for 5 years. The four satellites preceding GOES-5 also failed earlier than expected. The failure of the GOES-5 satellite has "created a lot of consternation," Callicott said, and some of the dynamics of the weather patterns have been missed. However, storm warnings can be issued adequately with GOES-6. The next GOES spacecraft is scheduled to be launched in May 1986.

Backup for the other troubled satellite, NOAA-8, is being provided by the NOAA-6 satellite. NOAA-6, which can cover much of the environmental monitoring lost by the failure of the NOAA-8 satellite, has the ability to process images, not soundings, however. The NOAA-8 satellite, launched March 28, 1983, is the first in a series of three advanced TIROS-N satellites. It began showing problems on June 12, according to Charles E. Thienel, deputy meteorological satellite project manager at the Goddard Space Flight Center. On that day, the satellite's gyros desynchronized. Continued clock disturbances interfered with the meteorological instruments, preventing the transmission of good data. Over the weekend of June 30 to July 1, the spacecraft began tumbling. The secondary oscillator, which would be the automatic backup to the primary oscillator that failed, is not accessible via remote control. The next advanced TIROS-N satellite, scheduled to be launched November 2, will be able to be controlled remotely, Callicott told *Eos*.—*BTR*

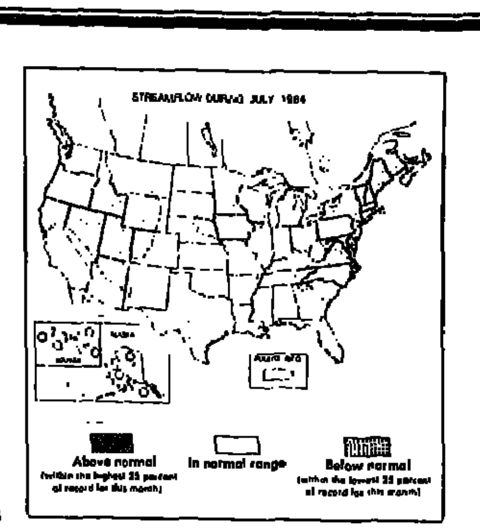
July Streamflows

Flows of most of the nation's key index streams were average to well above average in the first full month of summer, according to the U.S. Geological Survey (USGS), Department of the Interior.

A USGS network of 173 index gauging stations provided the regular month-end check of the status of streamflow conditions across the country. During July, flows at 83 sites (48%) were well above average, that is, in the upper 25% of long-term record. Seventy-one stations (41%) were in the normal range. Only 19 stations (about 11%) were in the lowest 25% of record.

The generally above average streamflow was reflected in conditions of the three major U.S. rivers. The combined average flow of the Mississippi, St. Lawrence, adn Columbia rivers was 820 billion gallons per day (bgd), or 30% above average for the month. The three rivers drain more than half of the lower 48 states, thus providing hydrologists with a quick check on the status of the nation's water resources.

Average flows at the key USGS stream gauging stations were in the upper 25% of long-term record for July in most of the northeast; the Middle Atlantic states into Georgia; and the upper Midwest, Rocky Mountains, and Pacific Northwest states.



Record high or near record high average flows for July occurred at 18 key locations in 16 states: Alaska, California, Connecticut, Florida, Georgia, Iowa, Maine, Minnesota, Nevada, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, South Carolina, and Vermont. For example, flow of the Etowah River at Canton, Georgia, averaged a 1.1 bgd, the highest measured flow for July since recordkeeping began at the site in 1936.

In contrast to the many reports of streamflow in the record high range, record low or near record low flows occurred at seven sites; three in Hawaii, two in Texas—where drought conditions persisted—and one each in Alabama and Puerto Rico.

Hydrologist Hai Tang of the USGS National Center in Reston said that groundwater levels were above average over most of the country in July. Monthly low levels for July occurred at key observation wells in San Antonio and El Paso, Texas, reflecting the general below average precipitation and streamflow conditions that have persisted in parts of Texas for 11 of the last 12 months.

Tang said the contents of reservoirs were generally average to above average in most of the country, with exceptions noted in Texas, southern Oklahoma, and western Kansas.

The U.S. Geological Survey, in cooperation with state and local organizations, routinely gathers data on the quantity and quality of surfacewater and groundwater resources from more than 60,000 stations across the country.

Following is additional information on national water conditions:

Five Large Rivers. While the average flow of each of the "Big Five" rivers declined seasonally from the previous month, the individual streamflows of all were above the long-term average for July. The St. Lawrence River near Massena, New York, 197 bgd, 12% above average; the Ohio River at Louisville, Kentucky, 39 bdg, 24% greater than the long-term average; the Missouri River near Hermann, Missouri, 98 bgd, 101% above average; the Mississippi River at Vicksburg, Mississippi, 431 bgd, 58% above average; and the Columbia River at The Dalles, Oregon, 192 bgd, 6% greater than the long-term average.

Nevada. Streamflow was above average on the Virgin, Humboldt, and Walker rivers. The flow of the Humboldt was in the above normal range for the 25th consecutive month. Rainstorms in the last 10 days of July caused numerous flash floods in the Moapa Valley and Las Vegas.

Utah. The level of the Great Salt Lake declined more than 2 inches during July, after peaking early in the month at 4209.25 feet above sea level, which was 4.25 feet higher than on July 1, 1983.

Texas. Streamflow runoff was well below average across most of the state. Thirty-two of 37 reservoirs registered a decline in contents from the previous month. Groundwater levels were below average in key observation wells at Austin and Houston and reached new lows for the month of July at El Paso and San Antonio.

Long Valley Volcanic Update

A relatively low level of earthquake activity and reduced rates of ground deformation during the past year have led U.S. Geological Survey (USGS) scientists to conclude that the likelihood of imminent volcanic activity at Long Valley, Calif., is reduced from that of mid-1982 through 1983.

In a letter dated July 11, 1984, USGS Director Dallas Peck advised the California Office of Emergency Services that, based on the assessment of the current situation, a volcanic eruption does not pose an immediate threat to public safety in the Long Valley region.

James F. Davis, California state geologist and chief of the conservation department's mines and geology division, concurred with the USGS update. The conservation department acts as the geological advisor to the California Office of Emergency Services. The Department of Conservation acts as the geological advisor to the California Office of Emergency Services.

USGS scientists, working with state, local, and university officials, reported that earthquake activity within the Long Valley caldera and in the Sierra Nevada immediately south of the caldera has persisted at a relatively low level, with short periods of increased activity, since a strong earthquake swarm shook the area in early January 1983 (*Eos*, February 8, 1983, p. 49; March 1, 1983, p. 81; March 29, 1983, p. 122). Quake activity within the caldera has averaged one to two earthquakes of magnitude 1 or greater daily; an occasional earthquake with a magnitude greater than 3 has been felt occasionally in the region. The two largest earthquakes to occur in the caldera since the January 1983 swarm were a magnitude 4.2 shock on April 28, 1984, and a magnitude 3.8 event on July 16, 1984. This most recent event, recorded July 15–16, was part of a swarm of several hundred earthquakes centered about 2.4 km east of Mammoth Lakes. It was similar to swarms that occurred repeatedly in the same area between May 1980 and May 1982.

In addition, geodetic networks show that ground deformation within the caldera has slowed significantly compared to rates from mid-1979 to January 1983. Horizontal extension is continuing in the southern part of the caldera near the site of the January 1983 earthquake swarm, but there has been only sight vertical uplift or ground swelling since January 1983.

Peck advised, however, "Even with this reduced level of activity, Long Valley still has one of the highest microearthquake rates in California and the ongoing horizontal deformation rates in the southern section of the Long Valley area are nearly 10 times greater than those routinely measured along the earthquake-prone San Andreas fault system. For these reasons, and because of geologic evidence of recent volcanism in the region, the area must still be recognized as having the potential for volcanic activity."

The USGS continues to monitor the region closely. David P. Hill is the chief scientist for the USGS monitoring efforts in the Long Valley region.

New Space Office

The National Aeronautics and Space Administration (NASA) has established an Office of Space Station to direct the agency's efforts to develop a permanently manned space station within a decade (*Eos*, February 14, 1984, p. 51).

The new program office, located at NASA headquarters in Washington, D. C., will provide overall policy and program direction for the space station program. The space station program office at the Johnson Space Center in Houston, Tex., will report to the new program office. Space station project offices at other NASA centers will be responsible to the new office through Johnson Space Center. The Johnson Space Center was named the lead center for the space station in February.

Philip E. Culbertson, appointed associate administrator for space station, will head the new program office. The deputy associate administrator for space station will be John D. Hodge. Culbertson had been associate deputy administrator of NASA since November 1981. Hodge had been director of the space station task force since May 1982; this past April he had been appointed acting deputy director of the interim space station program office.

Precambrian Geological Evolution

Geologists from Brazil, the three Guianas, Venezuela, the northern Andean countries, North America, and Europe are participating in a new project of the International Geological Correlation Program, concentrating on the Precambrian geological evolution of the Amazonian region. Most of the major Precambrian rock units of the region are currently being studied by geologists in the various countries that have exposures of the Guiana and Guaporé shields, which make up the Amazonian craton. The craton is notable because of the great expanses of crust that formed in the Early Proterozoic. There are granite-greenstone terranes as extensive as those of the Archean provinces of the North American shield and high-grade gneiss and granulite terranes of both Archean and Proterozoic age. These provide opportunities to compare continental formation and evolution of Proterozoic age with their more ancient counterparts in other shields. Most of the craton was established in the Early Proterozoic and was affected by the Trans-Amazonian orogeny; about half of this was then covered by Middle Proterozoic intracratonic sedimentray basins, associated felsic volcanics, mafic intrusives, and epizonal granitoid rocks. The felsic magmatic rocks of the Middle Proterozoic are particularly extensive and well exposed: This must rank as one of the prime regions in the

News (cont. on p. 484)

News (cont. from p. 483)

world to study such rocks. Alkaline complexes with associated carbonatites occur in Brazil, Guyana, and Venezuela. All of the rock types mentioned have important ore deposits associated with them, and one of the goals of the project is to develop further understanding of the mineral potential and metallogenesis of the region.

Project 204 of the IGCP was officially formed in February 1983, with Wilson Texeira and Colombo Tassinari of the University of Sao Paulo, Brazil, as coordinators. An organizational meeting of geologists from Brazil, Colombia, Guyana, Venezuela, and The Netherlands took place in November 1983 in Manaus. A second meeting of the project was held in conjunction with the Second Amazonian Symposium in Manaus on April 8–12, 1984. Geologists from Brazil, Venezuela, Guyana, French Guiana, the United States and The Netherlands attended and presented papers.

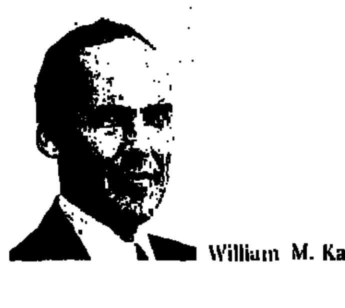
The Second Amazonian Symposium was held to commemorate the 50th anniversary of the Brazilian Departamento Nacional da Produçao Mineral (DNPM). Over 50 papers were presented, and a 518 page volume of proceedings was releasd at the time of the conference. The papers included virtually all of the major rock units of the shield, and the diverse subjects included the rare-earth contents of the Mesozoic dikes, soil development over copper deposits, argon dating of Venezuelan dikes, and stromatolites in the Cubencranquem Group. New geochronological data were presented for many parts of the craton. There is controversy concerning the proportion of the craton that existed prior to the Early Proterozoic: At one extreme, most of the craton is considered to be Archean, while others think that only the Imataca Province of Venezuela has been proven to be Archean. Similarly, though much of the crust of the western part of the craton has yielded Late Proterozoic ages, there is controversy about whether these ages represent new crustal additions or reworking of older crust. There were several presentations by government and company geologists who have been successful in recent mineral exploration in the Amazonian region. Breno dos Santos reported on the work of DOCEGEO in the Serra dos Carajas region, which has promising deposits of iron, copper, gold, manganese, and several other metals. Other papers described the Seis Lagos carbonatite exploration, the Pitinga tin deposits, and the Trombetas bauxite. Field trips to Carjas, Rondonia, Trombetas, and Boa Vista concluded the symposium.

A U.S. Working Group for this IGCP project was organized in late 1983 and was formally approved by the U.S. National Committee for the IGCP at its December 1983 meeting. About a dozen geologists who have previously done research in either the Amazonian region or the correlatable rocks in West Africa have indicated their interest in the project and in the U.S. Working Group. Many of the participants are involved in geochronological work, and they will bring to the project a valuable contribution of isotopic laboratory work. Other members of the Working Group are active in regional stratigraphic and metamorphic studies and paleomagnetic research. Recently formalized agreements between the Brazilian CNPQ and the United States National Science Foundation specifically encourage collaborative research between U.S. and Brazilian geologists. The National Science Foundation continues to support research by U.S. geologists in several other countries on the craton, and collaboration between U.S. geologists and the governments and companies in these countries also contributes to the project's research goals.

Allan Gibbs of Cornell University is coordinating the U.S. Working Group, and any geoscientists interested in research on the Precambrian geology of the region are welcome. Correspondence should be addressed to Allan Gibbs, Department of Geological Sciences, Cornell University, Ithaca, N. Y. 14853 (telephone 607-256-5282).

Geophysicists

William M. Kaula, chairman of the department of earth and space sciences at the University of California, Los Angeles, has been chosen to head the National Oceanic and Atmospheric Administration's National Geodetic Survey Division (NGSD), effective in September. His duties will include the readjustment of the horizontal network (NAD83), the readjustment of the vertical network (NAVD88), the newly started POLARIS VLBI earth rotation and polar motion service, and the introduction of the Global Positioning System to control surveying and its application to geodynamics. Kaula has been a professor of geophysics at UCLA since 1963.


William M. Kaula

Louis J. Lanzerotti, at Bell Laboratories in Murray Hill, N. J., has been appointed chairman of the National Aeronautics and Space Administration's (NASA) Space and Earth Science Advisory Committee. He succeeds ***Laurence A. Soderblom*** of the U.S. Geological Survey, Flagstaff, Ariz. The next meeting of the committee is scheduled for the end of October.

Jesse W. Moore has been appointed associate administrator for space flight at NASA. He has been serving as the acting associate adminstrator for space flight since April 15, 1984. He was appointed deputy associate administrator for space flight in February 1983.

Eugene M. Shoemaker of the U.S. Geological Survey and ***David Stevenson*** of the California Institute of Technology will receive the Kuiper and Urey prizes, respectively, awarded by the Division for Planetary Sciences of the American Astronomical Society. The Kuiper Prize is given annually in recognition of a scientist whose achievements have advanced significantly the understanding of planetary science. The Urey Prize, also awarded annually, recognizes and encourages outstanding achievement in planetary science by a young scientist. The prizes will be awarded at the AAS annual meeting in October.

The following AGU members were elected as Fellows of the American Association for the Advancement of Science on May 28: ***Charles C. Bates, Norman H. Brooks, Kenneth Davies, Robert E. Dickinson, J. Ernest Flack, Dave Fultz, J. Frederick Grassle, Donald M. Henderson, Andrew P. Ingersoll, Stig Lundqvist, Michael B. McElroy, Leslie H. Meredith, James N. Pitts, James V. Taranik, John Verhoogen***, and ***M. Gordon Wolman***.

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Airborne Research Associates/Atmospheric Scientist. Airborne Research Associates is seeking an experienced atmospheric scientist skilled in electronics, FORTRAN programming and statistics for meteorlogical/geophysical basic research. Primary responsibility is running a satellite image analysis investigation of large scale cloud variability using a specially developed interactive PDP 11/23 based system. The secondary responsibility involves participation in aircraft meteorological field programs. Research areas include atmospheric electricity, solar-terrestrial relations and marine boundary-layer processes including microturbulence and organized convection. Applicant should be a versatile self-starter. The company is small with associated advantages and disadvantages. Send resume, salary, three references to: Dr. R. Markson, ARA, 46 Kendal Common Road, Weston, MA 02193.

Research Associate. The Department of Geosciences at the University of Arizona anticipates two one-year positions for research associates during 1984–85 with experience in stable isotope mass spectrometry and vacuum line experience. Both positions require a fundamental understanding of stable isotope geochemistry. One position entails carrying out research in stable chlorine isotope variation. The other entails studying variations of stable carbon isotopes in tree rings. Salary for both positions will be $16,000. Ph.D. required. These two positions are dependent upon current grant continuation with possibility of extension for one additional year. The application deadline is September 7, 1984. All qualified applicants are urged to apply. Applicants should send vita with the name and telephone number of three references to: Dr. George Davis, Department Head, Department of Geosciences, The University of Arizona, Tucson, AZ 85721

The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

Oceanographic Programmer and Technician/Skidaway Institute of Oceanography. Skidaway Institute of Oceanography has an opening for a scientific programmer and technician. Preference will be given to applicants with an M.S. degree in an ocean or other geophysical science, but others with at least a B.S. will be considered. The applicant must demonstrate proficiency in FORTRAN and other aspects of computer science, particularly the interfacing of oceanographic equipment in software development and data management. Salary is negotiable and will be commensurate with experience and training. We anticipate filling this position on or before 1 November 1984.

Interested persons should send a resume including the names and addresses of three references to:

Dr. J.O. Blanton
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, Georgia 31416
912-356-2457.

Project Associate/Specialist: Electron Micro-Probe Lab, University of Wisconsin-Madison. Strong analytical background in quantitative EMP analysis and familiarity with computers is required. The Lab has a 9-spectrometer ARL SEMQ and a JEOLCO 50-A SEM. Duties will include instrument maintenance, instruction of students, development of procedures and analysis. Research will be encouraged. A MS or PhD is required in Earth Science, Chemistry, Physics or Engineering. Minimum salary will be $18,000/12 months with an MS. Send letter of application, transcripts, resume, and names and addresses of three references by September 15 to Dr. John W. Valley, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have established an outstanding reputation documentable through professional writings or other evidence of personal technical creativity, letters of reference from recognized research leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma physics would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the University. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is Professor Robert A. Helliwell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, CA 94305. Other members of the selection committee include Professor P.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler.

Geologists-Geophysicists/Institute for Geophysics, The University of Texas at Austin. The Institute for Geophysics at the University of Texas at Austin has openings for research staff, particularly in the areas of theoretical seismology and sea-going marine geology/geophysics. The Institute is located in Austin and operates closely with the Department of Geological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geology/geophysics. Research facilities include a 169-foot ship equipped with multichannel and high resolution seismic reflection and OBS seismic refraction capabilities. A VAX 11/780 computer with DISCO software is available for data processing.

Applicants should hold a Ph.D. in geology, geophysics or other appropriate field and have demonstrated creativity in research. Senior and mid-career researchers as well as recent Ph.D.'s are encouraged to apply. Applications should be received by September 15, 1984. The salary is dependent upon qualifications. Please forward applications, curriculum vitae, names of at least three references, and other supporting materials to: Dr. A.E. Maxwell, Director, Institute for Geophysics, The University of Texas at Austin, P.O. Box 7456, Austin, TX 78712.

The University of Texas is an equal opportunity/affirmative action employer.

Geochemist. The University of California, Davis, Department of Geology, has an opening for a one year temporary faculty position for Fall 1984. Specific fields are open; however specialization in isotope and economic geochemistry are desirable. The Department has strong programs in paleobiology, paleoceanography, petrology, geophysics, and crust and mantle evolution. A Ph.D. is required. Responsibilities include graduate and undergraduate teaching and research in geochemistry.

Applicants should submit vita, statement of research and teaching interests, and the names of three references as soon as possible, as the position is for the Fall, 1984 quarter.

We anticipate that this position will be opened on a permanent, tenure track basis during the next academic year. A successful candidate for this temporary position can apply for the tenure track position. Inquiries and applications should be sent to Chair, Search Committee, Department of Geology, University of California, Davis, Davis, California 95616.

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We invite applications for the position of Project Scientist for a major satellite experiment which will fly on the Upper Atmospheric Research Satellite. The selectee will conduct investigations to develop the technical tools necessary to study the variability of the Sun in the ultraviolet spectrum. He/She will be a co-investigator of the NRL-UARS experiment. In this capacity the selectee will conduct his/her own research in the area of solar variability and/or upper earth atmospheric physics

Qualifications required: A bachelors or higher degree in physics and at least three years of professional experience which involved performing basic and/or applied research in the fields of optics, spectroscopy, solar physics, or geophysics.

Interested applicants should submit a Personal Qualifications Statement (SF-171) or detailed resume by 28 September 1984 to:

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SOLAR PHYSICS BRANCH
SPACE SCIENCE DIVISION
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Civilian Personnel Division
Attn: 41-58-13.1 (EOS)
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Scripps Institution of Oceanography invites applications for a Postdoctoral position in Physical Oceanography to participate in theoretical and observational studies of the general circulation of the North Pacific Ocean. Ph.D. in physical or mathematical sciences, with a strong graduate level background in Fluid Dynamics, is required. Salary is commensurate with experience, with a minimum of $22,600 per annum. Position start date from October 1, 1984.

Please send resume and three letters of reference to Professor Pearn P. Niiler, Scripps Institution of Oceanography, A-030, La Jolla, CA 92093 by September 1, 1984.

The University of California, San Diego is an Equal Opportunity/Affirmative Action Employer.

The University of Bergen invites applications for a vacant

PROFESSORSHIP (CHAIR) IN PETROLEUM GEOLOGY

Salary is in scale 32 Nkr. 207 735 p.a. gross, of which Nkr. 3 649 p.a. are paid in pension contributions. The professor will be appointed on the understanding that any changes in scientific duties, pension or retiring age made by law or by the King with the agreement of Parliament are to be accepted without compensation.

Applicants should submit 5 copies of scientific work—published or unpublished—which they wish to be considered for the appointment as well as 6 copies of a list of all scientific contributions with information on where they are published. Scientific contributions are to be submitted, in numbered order and in 5 groups, to the science faculty of the University of Bergen within one month of the closing date for applications. Scientific manuscripts in preparation may be submitted within 3 months of the closing date for applications provided notice of intent is given on submitting the other publications. Applicants are otherwise referred to the current rules for the procedure to be followed in the appointment of professorships and readerships.

A résumé of the vacant professorship can be obtained on request from: *Sekretariatet for Det matematisk-naturvitenskapelige fakultet, Postboks 25, 5014 Universitetet i Bergen, Norway.*

Applications from women are especially encouraged, in accordance with the policy of the university.

Applications, which must include a complete curriculum vitae, should be addressed to the King and be sent together with relevant certificates and one copy of a list of publications to: Det matematisk-naturvitenskapelige fakultet, Postboks 25, 5014 Universitetet i Bergen, Norway before 1st November 1984.

WEATHER DATA ANALYSIS INTERACTIVE SYSTEMS DESIGN
PROFESSIONAL OPPORTUNITIES

The University Corporation for Atmospheric Research, headquartered in Boulder, Colorado, invites applications and nominations for the first two positions available with our UNIDATA project **PROJECT MANAGER** and **TECHNICAL COORDINATOR.** UNIDATA is a collaborative project whose next phase will involve the development of system specifications for hardware, interactive software, and a wide-area wideband communications network system enabling users in the academic community to conduct local interactive analysis of conventional and advanced weather data providing access to mainframe computers.

PROJECT MANAGER: Provides overall project management and ensures that the UNIDATA system is responsive to the needs of the academic community. Requires: MA/MS in meteorology, related field or equivalent combination of education and experience; skill in project management and in budget planning and management; skill in technical writing; skill in developing and maintaining effective diplomatic working relationships with diverse communities; expert knowledge in one with working knowledge in three of the following technical areas: 1) research/teaching use of meteorological data; 2) data communications; 3) software systems & meteorological applications; 4) graphics display workstation systems. Salary: $38,400 - $57,600/yr depending upon qualifications.

TECHNICAL COORDINATOR: Integrates the technical and engineering aspects of system design. Requires: MA/MS in meteorology with computer applications exp., MA/MS degree in computer science with meteorology applications exp., or equivalent combination of education/experience; expert knowledge and skill in software systems & data communications; skill in technical writing and project task planning; working knowledge of graphics display workstation systems; general knowledge of research/teaching use of meteorological data. Salary: $35,300 - $53,099/yr depending upon qualifications.

THESE ARE ONE-YEAR TERM POSITIONS WITH THE POSSIBILITY OF EXTENSION.

UCAR is a university consortium composed of 53 U.S. and Canadian Institutions dedicated to the advancement of the atmospheric and related sciences. UCAR's principle activity is the operation of the National Center for Atmospheric Research under the sponsorship of the National Science Foundation.

APPLICATION PROCEDURE: Please submit resumé in confidence to Nancy Lippincott, Employment Administrator, N.C.A.R., P.O. Box 3000, Boulder, Colorado 80307.

An Equal Opportunity Affirmative Action Employer

MARINE CHEMIST

The Chemistry Department of the Woods Hole Oceanographic Institution plans to make a tenure track appointment as Assistant Scientist and invites applications from reseachers with interest in the field of Marine Chemistry. Applicants should have a Ph.D., and preferably, post doctoral experience with a demonstrated interest in natural systems and strong basic physical, organic or analytical chemistry background to study chemical processes in marine systems. Experience with techniques in reaction kinetics and mass spectrometry would be particularly valuable. Interested candidates should send resume, transcript, reprints and names of potential referees, to:

Personnel Manager
Box 54 P

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, MA 02543
An equal opportunity employer M/F/H

Seismologist/Department of Geology/University of Illinois at Urbana-Champaign. Applications are solicited for a tenure track position at the Assistant Professor level in the general area of seismic imagery. The position is expected to be filled by Fall, 1985. Salary is commensurate with experience; an earned Ph.D. is required. A creative individual is sought who will develop a research program that can complement our existing programs in geodynamics, earthquake seismology, geotectonics, and rock/mineral physics. Specialists from subfields including reflection/refraction seismology, exploration seismology, marine or continental seismic profiling, and seismic tomography are encouraged to apply. An excellent research environment and outstanding facilities are available both in the Department of Geology and the University. Opportunity exists to interact with the Illinois State Geological Survey on campus. The successful candidate is expected to participate in all aspects of teaching and advising at the graduate and undergraduate levels. For equal consideration, interested individuals should send curriculum vitae, list of publications, statements of research interests and names of three or more references by December 15, 1984 to:

Professor Albert T. Hsui
Department of Geology
University of Illinois at Urbana-Champaign
1301 W. Green Street
Urbana, Illinois 61801
Telephone: 217-333-7732 or 333-3542

University of Illinois is an equal opportunity/affirmative action employer.

Hydrogeologist/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably assistant professor level, for which the first search will be for a creative individual working in applied geological hydrology.

The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applicants should submit a vita including names of references to M.C. Gilbert, Department of Geology, Texas A&M University, College Station, TX 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) micropaleontology-Tertiary biostratigraphy, 2) structure-tectonics, 3) hydrogeology, and 4) mineralogy-kinetics. Each person is expected to teach both undergraduate and graduate courses and to conduct a vigorous research program, including the supervision of graduate students, in the area of his or her speciality. The positions require the Ph.D. degree. Applicants should submit a detailed resume, names and addresses of five references, a statement of teaching and research interests, and a copy of their dissertation abstract by December 1, 1984 to: Dr. William L. Fisher, Department of Geological Sciences, the University of Texas at Austin, Austin, Texas 78713–7909.

The University is an equal opportunity/affirmative action employer.

University of Texas at Austin. The Department of Geological Sciences invites applications for a person to teach depositional systems and petroleum geology at the undergraduate and graduate levels and to conduct a vigorous research program, including the supervision of graduate students, in the area of the person's interest. The person must be willing to teach the above subjects to non-majors on occasion. The position requires the Ph.D. and is open to both tenure-seeking junior persons and senior-level persons. Availability by January 1985 is desirable. Applicants should submit a detailed resume, names and addresses of five references, and a statement of teaching and research interests by November 1, 1984 to Dr. Earle F. McBride, Department of Geological Sciences, University of Texas, Austin, Texas 78712. New Ph.D.-holders should also submit a copy of their dissertation abstract.

The University is an equal opportunity/affirmative action employer.

POSITIONS WANTED

Teaching and/or Research – Geology, Paleontology, Geophysics, Mining and Petroleum Engineering. Extensive practical and teaching experience in the US and abroad. Specialist in resource exploration and development—multilingual with fluent Persian and Turkish. Salary and rank negotiable. Reply to Box 026, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

Geohydrologists/Hydrogeologists

CH2M HILL, an employee-owned, multi-discipline Consulting Engineering firm with regional and project offices throughout North America and overseas, has positions for Geohydrologists/Hydrogeologists in the following offices: Redding, CA; Denver, CO; Gainesville, FL; Portland, OR; Seattle, WA and Milwaukee, WI.

Positions require a BS in Geology, Civil or Agricultural Engineering and a MS in Groundwater Hydrology or Hydrogeology with a basic understanding of geology and a thorough knowledge of aquifer mechanics, geochemistry, and computer modeling. Must have interest in project management, business development, and work in a team concept situation. Prefer a minimum of 5 years consulting engineering experience and total professional experience of 7 to 12 years. Qualifications should include working experience in:

- ***Groundwater resource evaluation and supply design.***
- ***Groundwater quantity and quality monitoring program design and implementing.***
- ***Groundwater quantity and quality modeling.***
- ***Groundwater contamination and cleanup.***

Salary commensurate with experience, excellent fringe benefits. An Equal Opportunity Employer. Qualified applicants send resume indicating geographic preference and salary requirements, in confidence, to Manager of Recruiting GEOHYG3, CH2M HILL, P.O. Box 428, Corvallis, OR 97339-0428.

CH2M HILL
Engineers
Planners
Economists
Scientists

Meetings

Housing and Registration

The 1984 Fall Meeting of the American Geophysical Union and the Winter Meeting of the American Society of Limnology and Oceanography (ASLO) will be held in San Francisco, December 3–7, at the Civic Auditorium.

San Francisco has been host to AGU's annual Fall Meeting for many years. If you have attended previous Fall Meetings, you know what a pleasing city San Francisco can be—fine restaurants, temperate December climate, and the charms of Chinatown, Ghirardelli Square, Fisherman's Wharf, Nob Hill, and North Beach. San Francisco is an elegant city, offering a rich blend of stylish hospitality and home town amiability. By any measure, San Francisco is an ideal backdrop for this year's scientific sessions.

Registration

Everyone who attends the meeting must register. Preregistration received by November 9 *saves you time and money. The fee will* be refunded to you if AGU receives written notice of cancellation by November 30. Registration rates are as follows:

	Preregistration	After November 9
Member (AGU/ASLO)	$70	$85
Student Member (AGU)	$30	$45
Retired Senior Member (AGU/ASLO)	$30	$45
Age 65 or over and retired from full-time employment.		
Nonmember	$95	$110
Student Nonmember	$40	$55

Registration for 1 day is available at one half the above rates, either in advance or at the meeting. Members of the American Congress on Surveying and Mapping, the American Meteorological Society, the American Society of Photogrammetry, the Canadian Geophysical Union, the European Geophysical Union, and the Union Geofisica Mexicana may register at the AGU/ASLO member rates.

If you are not a member of AGU and you register at the full nonmember meeting rate, the difference between member (or student member) registration and nonmember regis*tration will be applied to 1985 AGU dues if a* completed membership application is received at AGU by February 28, 1985.

To preregister, fill out the registration form, and return it with your payment to AGU by November 9. Preregistrants should pick up their registration material at the registration desk located at the Civic Auditorium in the Main Arena. Your receipt will be included with your preregistration material. Registration hours are 7:45 A.M. to 4:30 P.M., Monday through Friday. On Sunday, December 2, registration will be held at the Cathedral Hill Hotel. You may register from 4:00 P.M. to 8:00 P.M.

Hotel Accommodations

Blocks of sleeping rooms are being held at the following hotels:

- Cathedral Hill Hotel ($51 single/$55 double)
  - Free parking to registered guests
  - Limited shuttle service to and from the Civic Auditorium
  - Airport shuttle service available
  - Coffee shop opens 6:30 A.M.
- Holiday Inn Golden Gateway ($49 single/$55 double)
  - Free parking to registered guests
  - Limited shuttle service to and from the Civic Auditorium
  - Airport shuttle service available
  - Coffee shop opens 6:30 A.M.
- The Grosvenor Inn ($49 single/$55 double)
  - Limited shuttle service to and from the Civic Auditorium
  - Airport shuttle service available
  - Coffee shop opens 7:00 A.M.
- The Holiday Inn Civic Center ($49 single/$55 double)
  - Two blocks away from the Civic Auditorium
  - Free parking to registered guests
  - Airport shuttle service available
  - Coffee shop opens 6:30 A.M.
- The San Franciscan Hotel ($50 single/$56 double)
  - One block away from the Civic Auditorium
  - Airport shuttle service available
  - Parking $3 a day to registered guests
  - *Coffee shop opens 6:30 A.M.*
- Carriage Inn Hotel ($52 single/$54 double)
  - Victorian style inn
  - Free parking to registered guests
  - Walking distance to the Civic Auditorium
  - Shuttle service available to airport
  - Free continental breakfast and newspaper
- Americania Hotel ($49 single/$54 double)
  - Free parking to registered guests
  - Walking distance to the Civic Auditorium
  - Shuttle service available to airport
  - Free coffee served in sleeping rooms
- Flamingo Motor Inn ($43 single/$43 double)
  - Free parking to registered guests
  - Walking distance to the Civic Auditorium
  - Shuttle service available to airport
- Hotel Britton ($35 single/$38 double)
  - Inexpensive parking available to registered guests
  - Walking distance to the Civic Auditorium
  - Coffee shop opens 7:00 A.M.
  - Shared baths

The Cathedral Hill, Holiday Inn Golden Gateway, and the Grosvenor hotels are approximately a mile away from the Civic Auditorium. Limited shuttle bus service will be provided from these hotels to the Civic Auditorium for those who do not want to walk.

Read the housing application, and mail the completed application form to the housing bureau early to ensure reservations at your preferred hotel. Reservation forms must be sent directly to the Housing Coordinator, AGU Fall Meeting, San Francisco Housing Bureau, P.O. Box 5612, San Francisco, CA 94101. Do not send housing reservation forms to the hotel.

Reservations must be received by October 31 *to* be confirmed. Do not write or call AGU for room reservations.

Scientific Sessions

The Call for Papers, including specifications for abstracts, was published in the July 3 and August 14 issues of *Eos*. The program summary will be published in the October 16 *issue of Eos. The preliminary program with* the abstracts will be published in the November 5 issue of *Eos*. The final meeting program, with presentation times, will be distributed at the meeting. All scientific sessions will be held at the Civic Auditorium.

Exhibits

Exhibits of instrumentation equipment, book publishers, program of government agencies, and other exhibits will be located at the Civic Auditorium in the Main Arena. The exhibits will be open Tuesday, December 4, through Thursday, December 6, 9:00 A.M. to 5:00 P.M. daily.

The following exhibitors are confirmed to date:

Academic Press
American Congress on Surveying and Mapping
American Society of Limnology and Oceanography
Elsevier Science Publishing Company, Inc.
Jet Propulsion Laboratory/TOPEX Project
Kinemetric, Inc.
Kluwer Academic Publishers (D. Reidel)
National Science Foundation
Nature's Own
NOAA/National Ocean Service
Pacific Delight
Qualimetrics, Inc./Weathertronics
Schonstedt Instrument Company
Sprengnether Instruments
Springer-Verlag, New York Office
Teledyne Geotech
Terra Technology Corporation

Social Functions

All meeting participants are invited to attend these events:

- Icebreaker party
  Monday, 6:00–7:30 P.M.
  Holiday Inn Golden Gateway
- Wine Reception
  Thursday, 6:00–7:30 P.M.
  Cathedral Hill Hotel
- Complimentary refreshments will be served daily at the Civic Auditorium

Business Meetings and Section Luncheons

The AGU Council will meet Tuesday, December 4, at 5:30 P.M. Members are welcome to attend.

ASLO will hold a no-host smoker (cash bar), Tuesday, December 4, at 5:30 P.M.

The section luncheons will be held at the San Franciscan (SF) and Holiday Inn-Civic Center (HICC) hotels. Please indicate on the registration form which luncheon you plan to attend and include payment.

AGU Council Meeting
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel

ASLO No-Host Smoker
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel.

Tuesday, December 4, Noon
Geomagnetism and Paleomagnetism (HICC), $11.50
Planetology/Volcanology, Geochemistry and Petrology (SF), $11.50
Seismology (SF), $7.50

Wednesday, December 5, Noon
Geodesy (SF), $11.50
Ocean Sciences/ASLO, (SF), $11.50
Solar Planetary Relationships (HICC), $11.50

Thursday, December 6, Noon
Atmospheric Sciences (SF), $11.50
Hydrology (HICC), $11.50
Tectonophysics (SF), $11.50, Speaker: Dr. Barry Raleigh, Director, L-DGO

RETURN THIS FORM WITH PAYMENT TO:

Meeting Registration
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Or Call: Toll free 800-424-2488
or
Meetings 202-462-6903

PLEASE PRINT CLEARLY

NAME ON BADGE ______________________

AFFILIATION (for badge) ______________________

MAILING ADDRESS ______________________

____

____

TELEPHONE # ______________________
HOTEL ______________________

Days you plan to attend
Please check the appropriate box(es)
☐ Mon ☐ Tues ☐ Wed ☐ Thur ☐ Fri

Please check appropriate box.
Members of ASLO and the cooperating societies may register at AGU member rates
☐ Member AGU ☐ Member ASLO ☐ Nonmember
☐ Member cooperating society
☐ AMS-American Meteorological Society
☐ ASP-American Society of Photogrammetry
☐ ACSM-American Congress on Surveying and Mapping
☐ EGU-European Geophysical Union
☐ UGM-Union Geofisica Mexicana
☐ CGU-Canadian Geophysical Union

Nonmembers

If you register at the full-meeting nonmember rate, the difference between member (or student member) registration and nonmember registration will be applied to AGU dues if a completed membership application is received at AGU by February 28, 1985.

Preregistrants

Your receipt will be in your preregistration packet. The registration fee will be refunded if written notice of cancellation is received in the AGU office by November 30. The program and meeting abstracts will appear in the November 6 issue of Eos.

AGU 1984 Fall Meeting
DECEMBER 3–7
San Francisco, California
ASLO WINTER MEETING

REGISTRATION FORM

Deadline for Receipt of Preregistration November 9, 1984

(rates applicable only if received by November 9 with payment)

	More than one day	One day
MEMBER	☐ $70	☐ $35
STUDENT MEMBER	☐ $30	☐ $15
*RETIRED SENIOR MEMBER	☐ $30	☐ $15
NONMEMBER	☐ $95	☐ $47.50
STUDENT NONMEMBER	☐ $40	☐ $20

*Age 65 or over and retired from full-time employment

SECTION LUNCHEONS

Circle section and indicate number of tickets. All lunches begin at noon.

____ Geomagnetism and Paleomagnetism, Tuesday, $11.50
____ Planetology/Volcanology, Geochemistry and Petrology, Tuesday, $11.50
____ Seismology, Tuesday, $7.50
____ Geodesy, Wednesday, $11.50
____ Ocean Sciences/ASLO, Wednesday, $11.50
____ Solar-Planetary Relationships, Wednesday, $11.50
____ Atmospheric Sciences, Thursday, $11.50
____ Hydrology, Thursday, $11.50
____ Tectonophysics, Thursday, $11.50

Total Enclosed $ ______________
(All orders must be accompanied by payment or credit card information. Make check payable to AGU.)

Charge to: ☐ American Express ☐ Visa ☐ Master Card

Card Number ______________
Master Card Interbank No. ______________
Expiration Date ______________
Signature ______________

Office Use: Code ____ Check No. ____

HOTEL ACCOMMODATIONS
PARTICIPATING HOTELS

Cathedral Hill Hotel
($51 Single/$55 Double)
Van Ness at Geary
(800) 227-4730

Holiday Inn Golden Gateway
($49 Single/$55 Double)
1500 Van Ness Avenue
(415) 441-4000

Grosvenor Inn
($49 Single/$55 *Double*)
Van Ness at Geary
(415) 673-7411

Holiday Inn Civic Center
($49 Single/$55 Double)
50 8th Street
(415) 626-6103

San Franciscan Hotel
($50 Single/$56 Double)
1231 Market Street
(415) 626-8000

Carriage Inn
($52 Single/$54 Double)
140 Seventh Street
(800) 227-4368

Americania
($49 Single/$54 Double)
121 Seventh Street
(800) 227-4368

Flamingo Motor Inn
($43 Single/$43 Double)
114 Seventh Street
(800) 227-4368

Hotel Britton
($35 Single/$38 Double)
112 Seventh Street
(800) 227-4368

All hotel reservations must be made on the housing form by October 31, 1984. No telephone request will be accepted. Confirmations will be mailed directly to registrants by the individual hotels. A first nights deposit may be required by the hotel to guarantee your room. Changes and cancellations should be made directly to the hotel.

Mail your completed housing form directly to:

Housing Coordinator
AGU Fall Meeting
San Francisco Housing Bureau
P.O. Box 5612
San Francisco, CA 94101

American Geophysical Union
1984 FALL MEETING
ASLO WINTER MEETING

HOUSING REGISTRATION FORM

READ CAREFULLY and RETURN FORM DIRECTLY TO THE SAN FRANCISCO HOUSING BUREAU AT THE FOLLOWING ADDRESS:

Housing Coordinator
AGU Fall Meeting
SF Housing Bureau
P.O. Box 5612
San Francisco, CA 94101

Please print or type all information, abbreviating as necessary. Confirmation will be sent by the hotel to the individual named in Part I. If more than one room is required, this form may be photocopied.

Part I

REQUESTOR

Last Name ______________ First ______________

Name of Company or Firm ______________

Street Address or P.O. Box Number ______________

City ______________ State/Prov. ______ Zip-U.S.A. ______

Country ______________ Telephone Number ______________

Part II

INSTRUCTIONS: Select FOUR Hotels of your choice from the list of participating facilities, then enter the name on the lines below.

First Choice ______ Second Choice ______ Third Choice ______ Fourth Choice ______

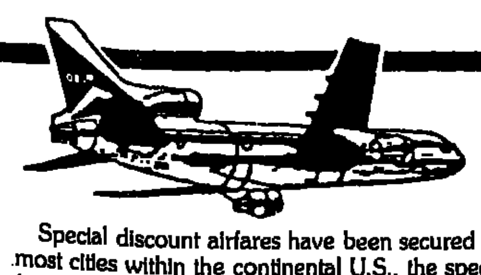
NOTE: Rooms are assigned on a "First Come, First Served" order, and if none of your choices are available, another facility will be assigned based on a referral system. A cut-off date is in effect; your application may not be processed if received after 14 days prior to your arrival date. **AGU housing registration deadline is October 31.**

Part III

INSTRUCTIONS:
1. Select type of room desired with arrival and departure dates.
2. *PRINT* or *TYPE* names of *ALL* persons occupying room.
3. If more than two persons share a room, check twin and the hotel will assign two double beds.

CHECK ONE		
☐ SINGLE (Room with one bed one person)	Arrival Date ______	Guest Names (Last name first)
☐ DOUBLE (Room with one bed two persons)	Arrival Time ______ AM/PM	1 ______
☐ TWIN (Room with two beds two persons)	Departure Time ______	2 ______
		3 ______
		4. ______

IMPORTANT NOTE: Hotel MAY require a deposit or some other form of guaranteed arrival. If so, instructions will be on your confirmation form.



SPECIAL AIRFARES
AGU 1984 FALL MEETING AND ASLO WINTER MEETING

San Francisco, California • December 3–7, 1984

Special discount airfares have been secured for this meeting. Available from most cities within the continental U.S., the special airfares are lower than coach fares and in many cases lower than super saver fares. Available from more than 40 cities, these fares have unrestricted minimum stay requirements and no advance purchase. These special coach fare discounts are valid from November 28–December 12, 1984.

Tickets can be reserved and purchased only through CONFERENCE AIR SERVICES (CAS), the official air traffic coordinator for this meeting. To reserve your flight to San Francisco using these discounted fares, call Conference Air Service toll free 800-336-0277 between 9:00 am and 5:30 pm EST, Monday through Friday (or in Virginia and Washington, DC area call 528-0114). CAS will instantly confirm your reservation on an available flight at the best airfare consistent with traveler requirements.

Below is a sample of the round-trip airfares that are CURRENTLY AVAILABLE TO AGU attendees as of August 1984 with the special discount fares alongside. Since ALL FARES ARE SUBJECT TO CHANGE WITHOUT NOTICE, PLEASE CALL EARLY. Only sample cities have been listed below. PLEASE CALL CAS for the applicable discount fare from your home city.

Round Trip Airfares To San Francisco	Regular Coach Fare	AGU Convention Discount
BOSTON	$952.00	$431.00
CHICAGO	796.00	407.00
DALLAS/FT. WORTH	700.00	351.00
NEW YORK	938.00	463.00
WASHINGTON, D.C.	912.00	408.00

NOTE: In the event of an increase or decrease in published airfares, the AGU special fare will remain lower!!